## 2.7 Commercial Space Transportation Program Area Description

### Mission

The overall mission of Commercial Space Transportation (AST) is to protect public health and safety, the safety of property, and U.S. foreign policy and national security interests; to encourage, facilitate, and promote U.S. commercial space launches; to enhance the international competitiveness of the U.S. commercial space transportation industry; to ensure compliance with international obligations of the U.S., and to facilitate new or improved U.S. space transportation infrastructure. AST continuously seeks to improve its services by undertaking initiatives to meet current and future demands.

AST has recently joined the R&D Executive Board in order to facilitate two-way synergies between the aviation and space transportation research programs of the FAA. The proposed AST R&D program is an initiative to provide structured and evolutionary services that keep pace with the global growth incommercial space transportation. The program's mission is to develop technology, practices, processes, and procedures that will continually improve the delivery of AST services.

### Intended Outcomes

The AST R&D program is the nation's primary vehicle for anticipating the evolution of a rapidly changing global industry. It applies stable, and minimal regulation fairly and expeditiously to help achieve, not only the AST mission, but also the FAA safety and system efficiency goals. The program contributes to the performance outcomes described below and represents increased value to the American public.

*Space Transportation Vehicle Safety*

The primary AST mission is to protect public health and safety and safety of property. Together with with many federal and state agencies, the U.S. commercial space transportation industry is developing advances in vehicle technology and in associated infrastructure. The program plans and develops regulations, guidance, licensing approaches and methods to assess the safety of evolving space transportation vehicles. Since some new vehicles are likely to have some aircraft-like characteristics, AST intends to work closely with the aviation lines of business to develop these approaches and methods. Partnerships are developing in the areas of Evolved Expendable Launch Vehicles, Reusable Launch Vehicles, and spaceports that can accommodate new or improved vehicles. The cooperative development and deployment of safe, capable, operable, reliable, and economical space transportation vehicles will enhance the international competitiveness of U.S. providers.

*Space Transportation Infrastructure*

A number of State agencies and private companies are planning to develop new or improved space transportation infrastructure to accommodate new space transportation vehicles. Some of these efforts also involve DOD or NASA, agencies which have generally constructed, owned, and operated a U.S space transportation infrastructure. FAA will need to play an increasingly important role, however, in protecting public health, safety, and the safety of property – especially at those sites where DOD and NASA have little or no involvement. Accordingly, AST will work to enhance its ability to assess safety of operations at non-Federal space launch and landing sites.

*Space and Air Traffic Management System*

In order to accommodate increasing numbers of launches and landings of space vehicles at increasing numbers of sites, AST is cooperating with ATS in the development of an integrated Space and Air Traffic Management System (SATMS). This system will help to manage our airspace to accommodate vehicles traveling to or from space in safe, efficient combination with other aircraft. AST has already prepared an initial Concept of Operations and has refined it to reflect public comments. AST will undertake to develop a detailed SATMS plan, based on the work already completed.

### Programs Area Outputs

The developmental outputs of the proposed AST R&D program vary in composition among operational concepts; modeling and simulation

studies; emergent technology evaluations; and procedures, standards, and guidance. Some specific examples of expected outputs from the AST R&D Program include:

- Protect Public Health and Safety and Safety of Property – The U.S. commercial space transportation industry has experienced no fatalities, serious injuries, or significant property damage. AST seeks to contribute to the continuation of this exemplary record.
- Enhance the International Competitiveness of the U. S. Commercial Space Transportation Industry – AST regulates commercial space launches, reentries, landings, and sites only to the extent necessary to protect public health and safety and the safety of property.

**Program Area Structure**

The proposed AST R&D program is structured to systematically encourage, promote, and facilitate the U.S. commercial space transportation industry while enhancing the International Competitiveness of the U.S. Commercial Space Transportation Industry.

The program strives to make the most effective and efficient use of available R&D resources in order to benefit U.S. commercial space transportation providers; the producers, owners, and operators of U.S. satellites; and the American public.

**Customer and Stakeholder Involvement**

The AST R&D program reaches and supports a broad spectrum of the space transportation community. The primary example of customer and stakeholder involvement is the Commercial Space Transportation Advisory Committee (COMSTAC). The full committee and its working groups on Technology and Innovation, Launch Operations and Support, Reusable Launch Vehicles, and Risk Management include senior executives from U.S. commercial space transportation entrepreneurial firms; large aerospace companies; the developers and providers of reusable and expendable launch vehicles; representatives of the satellite, space insurance, space law, and space finance industries; state government officials; and space advocacy organizations. COMSTAC has assisted AST in developing commercial launch forecasts and in reviewing the concept of operations for the Space and Air Traffic Management System.

**Accomplishments**

AST has yet to participate officially in the R&D program. The following is a partial listing of recent past accomplishments of the existing AST Operations and Research program:

- Developed a Concept of Operations for an integrated Space and Air Traffic Management System.
- Developed criteria for RLV Operations and Maintenance.
- Developed criteria for space medical standards affecting passengers and/or crew.

**R & D Partnerships**

The AST Operations research program has established partnerships with diverse U.S. and international agencies, organizations, institutions, and industrial groups. A list of some recent and current partnerships follows:

- U. S. Government Agencies
  - Department of Commerce
  - Department of Defense
  - Department of State
  - Federal Communications Commission
  - National Aeronautics and Space Administration
  - National Oceanic and Atmospheric Administration
- International Organizations
  - International Maritime Satellite Organization
  - International Telecommunications Satellite Organization
  - United Nations Committee on the Peaceful Uses of Outer Space
- Academic Institutions
  - International Space University
  - Massachusetts Institute of Technology
  - Virginia Polytechnic Institute and State University
- Non-Profit Organizations

  - RTCA Inc.
  - Commercial Space Transportation Industry
  - Space Transportation Association
  - Satellite Industry
  - Satellite Industry Association
- Industry Groups
  - Aerospace Industries Association
  - American Institute for Aeronautics and Astronautics

**Long-Range View**

The essence of the proposed AST R&D program is to maintain a long-range view of the research requirements for safe, capable, operable, reliable, and economical space transportation provided by the U. S. private sector. As the newest mode, commercial space transportation is now – and is likely to remain for some time – a research-intensive industry. Technological advances in expendable and reusable launch vehicles, as well as increasing numbers of launches and launch sites, will require increasing attention to research.

## Commercial Space Transportation Safety

**GOALS:**

**Intended Outcomes:**

*Commercial Space Integration into the NAS*

The FAA intends to investigate and analyze means to integrate commercial space transportation operations seemlessly into the National Airspace System (NAS) in order to minimize impacts on overall NAS efficiency. Specifically, the FAA's Space and Air Traffic Management System initiative, as led by the Commercial Space Transportation (CST) line of business, seeks to examine methods to integrate new spaceport and vehicle operations in the NAS in a safe and efficient manner.

*Reusable Launch Vehicles Operation and Maintenance*

The FAA intends to investigate and analyze standards and processes applicable to commercial Reusable Launch Vehicle (RLV) Operations and Maintenance (O&M) activities to ensure these activities are conducted with adequate protection of public safety. A thorough review of the Space Shuttle operations and maintenance activities will be conducted to determine the "best practices" used by the world's only reusable launch vehicle and their applicability to commercial RLV O&M activities. The FAA will also study the airline industry to determine which "best practices" and "lessons learned" from the aircraft industry could be applicable to commercial RLV activities in terms of their operations and maintenance activities and the effects on safety.

*Criteria for Determining "Unproven" vs. "Proven" RLVs*

The FAA intends to improve public safety regarding the operation of unproven and proven commercial RLVs by the development of criteria that formulate a basic methodology to assist in the determination of when an RLV progresses from an "unproven" to "proven" status. The major objectives of this program are to:

- Continue public safety that is associated with RLV activities by providing additonal criteria for the safe operation of RLVs.
- Ensure that for proven RLV the projected instantaneous impact point (IIP) for any RLV mission or reentry shall not have substantial dwell time over densely populated areas.
- Ensure that for unproven RLVs:
  - The projected instantaneous impact point (IIP) of the vehicle does not have substantial dwell time over populated areas; or
  - The expected average number of casualties to members of the public does not exceed $30 \times 10^{-6}$ ($E_c \leq 30 \times 10^{-6}$) given a probability of vehicle failure equal to 1 ($p_f=1$) at any time the IIP is over a populated area.
- Provide criteria that can be used to assist in judging the public safety relevance of methodologies associated with proven RLV.

*Reetry Vehicle Maneuverabililty and its Effect on Public Safety*

The FAA intends to improve public safety regarding reentry of RLVs and reentry vehicles (RV) by understanding the safety issues associated with the level of maneuverability of the vehicle reentering earth. The foremost issue is the differentiation between maneuverable and non-maneuverable reentry vehicles. Although many trajectory analyses should be performed for both maneuverable and non-maneuverable RVs/RLVs, the results of the analyses and their relative importance toward public safety may differ greatly depending upon the maneuverability capability of the vehicle. The major outcomes from this program include:

- Continue improvement of public safety from RLV activities.
- Refine the RLV regulations to improve public safety and keeping with development of regulations that are not overly burdensome.
- Establish guidance and understanding of a vehicle's reentry $3\sigma$ left and right, minimum, and maximum Instantaneous Impact Point (IIP) trajectories that will indicate where a non-maneuverable vehicle will start its landing cycle (i.e., deploy its parachute) and land.
- Establish guidance and understanding of a maneuverable vehicle's reentry $3\sigma$ limiting

trajectories and the "maneuverability landing-ellipse" for the vehicle.

- Develop criteria that address maneuverable vehicles landing ellipse borders defined as a group of termination (impact) points for trajectories from which the vehicle could still maneuver sufficiently to attain a nominal landing location.
- Determine what trajectory information would be required to evaluate non-maneuverable and maneuverable RLVs/RVs.

**Agency Outputs:**

*Commercial Space Integration into the NAS*

- Develop a study of launch/reentry impacts from Kennedy Space Center on air traffic.
- Investigate policy options for improving "user access" to airspace.
- Develop a Spaceport Simulation and Assessment Model (SSAM).

*Reusable Launch Vehicles Operation and Maintenance*

The FAA establishes licensing criteria for reusable launch vehicle activities and Advisory Circulars (AC) to provide guidance for meeting these rules. The results of these commercial RLV O&M studies will be utilized to provide inputs to a draft Notice of Proposed Rule Making (NPRM) for commercial RLV operations and maintenance.

*Criteria for Determining "Unproven" vs. "Proven" RLVs*

FAA maintains public safety affiliated with RLV launch and reentry activities by the development of regulations that identify the requirements for safe RLV operations. FAA published on September 19, 2000, the following documents that are related to RLVs:

- Commercial Space Transportation Reusable launch Vehicle licensing regulations.
- Advisory Circular 431.35-1: Expected Casualty Calculations for Commercial Space Launch and Reentry Missons.
- Advisory Circular 431.35-2: Reusable launch and Reentry Vehicle System Safety Process.

This research program provides the resources to address the concerns regarding how to determine when an RLV is a proven vehicle. To establish that an RLV has been proven is highly depended upon such issues as the vehicle design, launch environment, ascent and decent environment, operational process, and test programs (vehicle and operations). Furthermore, it may not, at this time, be beneficial to develop a set of requirements that could be applied to all RLVs without AST obtaining a broad knowledge of commercial RLV designs and operations. To accomplish this, a commercial RLV industry similar to the present aircraft industry must exist. However, a research program could be developed to frame the type of criteria and/or methodology that can be applied to today's RLV concepts. These criteria could provide a method for determining, on a case by case basis, if a particular RLV should be upgraded to proven status.

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- Advisory Circular 431.35-2: Reusable launch and Reentry Vehicle System Safety Process.

This research program provides the resources to address the concerns regarding how to address the public safety issues associated with reentry of vehicles that are non-maneuverable and maneuverable. The research program could develop and frame the type of criteria and/or methodology that can be applied to the RLV concepts to provide a method for determining, on a case by case basis, the vehicle reentry maneuverability safety issues.

**Customer/Stakeholder Involvement:**

*Commercial Space Integration into the NAS*

In response to the projected growth and increased complexity of the commercial space transportation industry, the Commercial Space Transportation Space Systems Development Division has been actively leading an effort to integrate new operations seamlessly into the NAS. The Space and Air Traffic Management System Project is a key Systems Integration effort in support of the FAA's strategic goals.

*Reusable Launch Vehicles Operation and Maintenance*

The FAA Commercial Space Transportation Advisory Committee (COMSTAC) provides industry expertise to the Administrator and the Associate Administrator for Commercial Space Transportation (AST). The COMSTAC Reusable Launch Vehicle Working Group gives the FAA insight into the members' backgrounds and knowledge of systems and methodologies capable of protecting the public safety from the hazards associated with operations of RLVs.

The FAA Commercial Space Transportation Integrated Product Team (CST IPT) brings together the different FAA Lines of Business that will ensure the safety aspects of commercial RLV activities gets proper FAA corporate wide review and coordination.

*Criteria for Determining "Unproven" vs. "Proven" RLVs*

Criteria for determining unproven versus proven RLVs research includes:

- Support the FAA Associate Administrator for Commercial Space Transportation (AST) by providing a foundation to address and improve the process to determine the public safety issues regarding upgrading an RLV from unproven to proven.
- Provide the RLV industry with a less burdensome approach to classifying an RLV as a proven vehicle.
- Provide the customer with guidelines to furnish AST with the appropriate data regarding upgrading its RLV to a proven vehicle status. AST would evaluate and address the data public safety validity.
- The research and development project for "Criteria for determining unproven versus proven RLVs" might involve researching the following areas:
  - The Space Shuttle operation
  - Aircraft air worthiness
  - Automobile testing
  - Other related items that require approval for operation

*Reetry Vehicle Maneuverabililty and its Effect on Public Safety*

The reentry vehicle's maneuverability and its effect on public safety research:

- Supports the FAA Associate Administrator for Commercial Space Transportation (AST) by providing a foundation to address and improve the process to determine the public safety issues regarding reentry of maneuverable vehicles.
- Provide the RLV industry with a possibly less burdensome approach to regulate reentry of maneuverable vehicles.
- Provide customer guidelines to furnish AST with the appropriate data regarding reentry of maneuverable vehicles.
- The research and development project for "Reentry vehicle maneuverability and its effect on public safety" might involve researching the following areas:
  - The Space Shuttle operation
  - Aircraft air worthiness
  - Automobile testing
  - Other related items that require approval for operation

**Accomplishments:**

*Commercial Space Integration into the NAS*

The following R&D projects were accomplished in FY2000:

- Completed version 1.1 of the Comercial Space Transportation Concept of Operations in the National Airspace System.

- Completed a Space and Air Traffic Management System (SATMS) needs assessment.
- Completed phase III of a study to examine efficiency impacts of alternative policy options for accommodating space vehicle launch operations in the National Airspace System (NAS).
- Completed development of a SATMS Program Management Plan.

*Reusable Launch Vehicles Operation and Maintenance*

The FAA has produced a White Paper on "Commercial Reusable Launch Vehicle Operations and Maintenance Considerations." After this paper was reviewed by the FAA's CST IPT it was provided to the COMSTAC RLV Working Group for review and comment. Later, the paper was published by the American Institute of Aeronautics and Astronautics (AIAA) and presented by the FAA at the AIAA Space 2000 Conference and Exposition.

*Criteria for Determining "Unproven" vs. "Proven" RLVs*

The following results are from a previous research conducted to understand the general public safety issues associated with RLV operations. The earlier reseach, minimally, included unproven and proven RLV issues:

- Commercial Space Transportation Advisory Committee (COMSTAC) RLV Working Group developed an RLV Licensing Approaches report that included a discussion of unproven and proven RLVs.
- Develped for the RLV rulemaking effort a Technical Issues Memorandum (TIM) titled "The Risks Associated with Reentry Operations." The TIM addressed general safety issues pretaining to vehicle reentry.
- Refined the definition for RLV mission.
- Developed functional requirements for operation of an unproven and proven RLV.
- Published report: Critical Parameters for Successful Reentry From Earth orbit
- Published report: Reusable Launch Vehicle/ Reentry Vehicle Flight Safety System Issues.

*Reetry Vehicle Maneuverabililty and its Effect on Public Safety*

The following results are from a previous research conducted to understand the general public safety issues associated with RLV operations:

- Commercial Space Transportation Advisory Committee (COMSTAC) RLV Working Group developed an RLV Licensing Approaches report that included a discussion of unproven and proven RLVs.
- Develped for the RLV rulemaking effort a Technical Issues Memorandum (TIM) titled "The Risks Associated with Reentry Operations". The TIM addressed general safety issues pretaining to vehicle reentry.
- Published report: Critical Parameters for Successful Reentry From Earth orbit Report: Critical Parameters for Successful Reentry From Earth orbit.
- Published report: Reusable Launch Vehicle/ Reentry Vehicle Flight Safety System Issues.
- Published report: Reusable Launch Vehicle/ Reentry Vehicle Flight Safety System Issues.

**R&D Partnerships:**

*Commercial Space Integration into the NAS*

- International Center for Air Transportation, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology (NEXTOR).
- Space and Air Traffic Working Council (SATWC).
- NAS Architecture Core Team.

*Reusable Launch Vehicles Operation and Maintenance*

The FAA and NASA have a Memorandum of Understanding (MOU) Concerning Future Space Transportation Systems. It describes the FAA/ NASA cooperative activities that will be conducted under the category of future space transportation systems and reusable launch vehicle technology, research and development.

The FAA is actively involved with NASA and DoD activities that involve RLV technology demonstrations through programs such as X-40A,

X-37, X-34, and X-33, especially as related to public safety and environmental concerns.

*Criteria for Determining "Unproven" vs. "Proven" RLVs*

This program will work closely with various agencies and groups, such as:

- NASA Headquarters (HQ)
- NASA Kennedy Space Center (KSC)
- NASA Johnson Space Center (JSC)
- NASA Marshall Space Flight Center (MSFC)
- Aircrift certification (AIR)
- Flight standards (AFS)

*Reetry Vehicle Maneuverabililty and its Effect on Public Safety*

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- NASA HQ
- NASA KSC
- NASA JSC
- NASA MSFC
- Aircrift certification (AIR)
- Flight standards (AFS)
- Air traffic (AAT)

**MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:**

*Commercial Space Integration into the NAS*

- Developed commercial space transportation operation scenarios
- Impacted the analysis of Free Flight Phase 1 tools on commercial space transportation operations.
- Updated NAS Architecture to reflect CST changes.
- Identified schedule and cost impacts of CST requirements on NAS Architecture.

*Reusable Launch Vehicles Operation and Maintenance*

- Reviewed and analyzed the Space Shuttle operations and maintenance activities to determine "best practices" applicable to commercial RLV O&M activities.
- Conducted a study to review the airline industry operations and maintenance activities to determine the "best practices" and "lessons learned" that may be applicable to commercial RLV O&M activities.

*Criteria for Determining "Unproven" vs. "Proven" RLVs*

- Determined the resources required to conduct the research program.
- Developed a white paper addressing some of the public safety issue regarding unproven and proven RLVs.
- Reetry Vehicle Maneuverabililty and its Effect on Public Safety
- Determined the resources required to conduct the research program.
- Developed a white paper that addresses some of the public safety issues regarding non-maneuverable and maneuverable reentry vehicles.

**KEY FY 2002 PRODUCTS AND MILESTONES:**

*Commercial Space Integration into the NAS*

Prepare the SATMS Requirements Baseline Document.

*Reusable Launch Vehicles Operation and Maintenance*

Develop a draft NPRM to initiate the rule making activity for commercial RLV O&M activities to ensure that the public receives adequate protection during the course of these activities.

*Criteria for Determining "Unproven" vs. "Proven" RLVs*

- Develop a methodology that could lead to criteria for judging whether an unproven RLV can be upgraded to proven status.
- Develop a report on the research findings.

*Reetry Vehicle Maneuverabililty and its Effect on Public Safety*

- Develop a methodology that could lead to criteria for judging the public safety validity resulting from the reentry vehicle maneuverability.
- Develop a report on the research findings.

**FY 2002 PROGRAM REQUEST**: Authorized commercial space transportation research is currently being funded out of the Operations budget.

## APPROPRIATION SUMMARY

| | Amount ($000) |
|---|---|
| Appropriated (FY 1982-2000) | $0 |
| FY 2001 Enacted | 0 |
| FY 2002 Request | 0 |
| Out-Year Planning Levels (FY 2003-2006) | 0 |
| Total | $0 |

| Budget Authority ($000) | FY 1998 Enacted | FY 1999 Enacted | FY 2000 Enacted | FY 2001 Enacted | FY 2002 Request |
|---|---|---|---|---|---|
| Contracts: | | | | | |
| Commercial Space Transportation Safety | 0 | 0 | 0 | 0 | 0 |
| Personnel Costs | 0 | 0 | 0 | 0 | 0 |
| Other In-house Costs | 0 | 0 | 0 | 0 | 0 |
| **Total** | **0** | **0** | **0** | **0** | **0** |

| OMB Circular A-11, Conduct of Research and Development ($000) | FY 1998 Enacted | FY 1999 Enacted | FY 2000 Enacted | FY 2001 Enacted | FY 2002 Request |
|---|---|---|---|---|---|
| Basic | 0 | 0 | 0 | 0 | 0 |
| Applied | 0 | 0 | 0 | 0 | 0 |
| Development (includes prototypes) | 0 | 0 | 0 | 0 | 0 |
| **Total** | **0** | **0** | **0** | **0** | **0** |

**Notes:**

**- Commercial Space Transportaion Safety funding is included in the Operations Appropriation.**

**- Programs and projects are not separately budgeted in Operations Appropriation.**

**- Out year funding is under review.**

| Commercial Space Transportation Safety Products and Activities | FY 2002 Request ($000) | Program Schedule | | | | | |
|---|---|---|---|---|---|---|---|
| | | FY 2001 | FY 2002 | FY 2003 | FY 2004 | FY 2005 | FY2006 |
| *Commercial Space Integration into the NAS* | | | | | | | |
| Execute SATMS Program Management Plan | * | | | | | | |
| Validate near term CST operational scenarios | | ◆ | ◇ | | | | |
| Develop mid and far term CST operational scenarios | | ◆ | ◇ | ◇ | | | |
| Examine impacts of Free Flight tools on CST | | ◆ | ◇ | ◇ | ◇ | ◇ | ◇ |
| *Reusable Launch Vehicle Operations & Maintenance* | | | | | | | |
| Conduct Studies on Aerospace Operations &Maintenance | * | | | | | | |
| Investigate Space Shuttle O&M for Best Practices | | ◆ | ◇ | ◇ | | | |
| Analyze Airline O&M Activities for Best Practices | | ◆ | ◇ | ◇ | ◇ | ◇ | |
| Study Airline O&M Activities for Lessons Learned | | ◆ | ◇ | ◇ | ◇ | ◇ | ◇ |
| Criteria for Determining "Unproven" versus "Proven" RLVs | | | | | | | |
| Program Management Plan | * | | | | | | |
| Establish and implement near term research approach | | ◆ | ◇ | | | | |
| Develop draft criteria | | ◆ | ◇ | ◇ | | | |
| Develop mid term report | | ◆ | ◇ | ◇ | ◇ | | |
| Final report | | ◆ | ◇ | ◇ | ◇ | ◇ | |
| Reentry Vehicle Maneuverability and its Effect on Public Safety | | | | | | | |
| Program Management Plan | * | | | | | | |
| Establish and implement near term research approach | | ◆ | | | | | |
| Develop draft criteria | | ◆ | ◇ | | | | |
| Develop mid term report | | ◆ | ◇ | ◇ | | | |
| Final report | | ◆ | ◇ | ◇ | | | |
| Total Budget Authority | * | * | * | * | * | * | * |

**Note:**

– Commercial Space Transportation Safety Funding is Included in the Operations Appropriation.

– Programs and Projects are not separately budget in the Operations Appropriation.

* Funding requests for all years are under review.